ENTOMOLOGY.—*Preliminary life-history studies in Guam of the scarab beetle* Ancylonycha mindanaona (*Brenske*).[1] R. G. OAKLEY, U. S. Bureau of Entomology and Plant Quarantine. (Communicated by ALAN STONE.)

Severe attacks by larvae of the scarab *Ancylonycha mindanaona* (Brenske) on the Island of Guam in 1937–38 destroyed many young corn plantings. The insect, probably introduced from the Philippine Islands at some undetermined time, first occurred in damaging numbers on corn in 1935, according to reports, but became of increasing importance in 1937. These destructive appearances of the beetle may have been sporadic in nature, or they may have been due to a population build-up during the years subsequent to its supposed introduction. Its future importance to Guam's major food crop is a matter of conjecture.

To determine the habits of the insect as a basis on which to attempt control measures, studies of the pest were conducted by the writer during the period from June, 1937, to July, 1939, at odd times when other duties, including the enforcement of plant quarantines, permitted. Owing to the discontinuity of these studies and lack of equipment, the results obtained can not be considered either conclusive or complete. The data acquired may be of some value to Island agriculture, however, and are therefore summarized below.

HISTORY

Ancylonycha mindanaona was described by Brenske in 1893 under the generic name *Holotrichia* from specimens collected on the Island of Mindanao, Philippine Islands. It is probably indigenous to the Philippines, where its importance is unknown to the writer, literature on the subject not being available. Dammerman (1929) reported a related species, (*Holotrichia*) *A. vidua* (Sharp), as a commonly mentioned root pest there in 1929, and Lopez (1931) stated in 1929 that a little-studied species of *Ancylonycha*, probably *vidua*, was responsible for extensive damage to sugarcane.

The presence of *Ancylonycha mindanaona* in Guam was first definitely established in 1936 when Swezey submitted specimens collected on banana leaves to the Bureau of Science, Manila, P. I., for specific determination. Vandenberg (1931) recorded "*Lachnosterna* sp." as attacking pineapple roots on Guam. It is considered possible that he had reference to the form identified as *mindanaona* by the Bureau of Science, and by Böving at the United States National Museum in 1937 from specimens collected in Guam.

DISTRIBUTION IN GUAM

Nine of the Island's 17 districts were known to be infested by *Ancylonycha mindanaona* in July, 1939, although damaging infestations of outstanding importance had been found only in the districts of Asan, Tumon, and Dededo. The thickly dotted areas in Fig. 1 represent those districts bearing the heavier infestations, whereas the thinly dotted areas in the districts of Sumay, Piti, Agana, Sinajana, Barrigada, and Yona represent localities where infestations were more sparsely distributed. Significant damage to economic crops was only rarely found in the lightly infested districts.

ECONOMIC IMPORTANCE

The economic value of crops destroyed in Guam by *Ancylonycha mindanaona* was insignificant when compared with damage inflicted by a major pest in the United States. To the Guam farmer, however, who can cultivate only a small acreage with his primitive hand tools, losses sustained from attacks of the pest on corn represented part of a season's labor and a subsequent lack of his principal food supply until a second crop could be produced 9 months later, when rainfall again became favorable. Some farmers, rather than attempt to continue cultivations and suffer crop losses, actually

[1] The writer gratefully acknowledges the cooperation of the Naval Government of Guam in supplying the excellent services of José I. Cruz to assist in investigative studies, and the kind assistance received from Dr. E. A. Chapin, curator of insects in the United States National Museum, who prepared the description of the adult in this paper, and from A. D. Cushman, who prepared the drawings. Received October 4, 1944.

transferred their farming operations to non-infested areas.

Both larvae and adults are very voracious feeders, the former attacking lateral and tap roots, the latter feeding on the leaves. In October, 1937, 10 fields of young corn located at Dededo exhibited plant losses

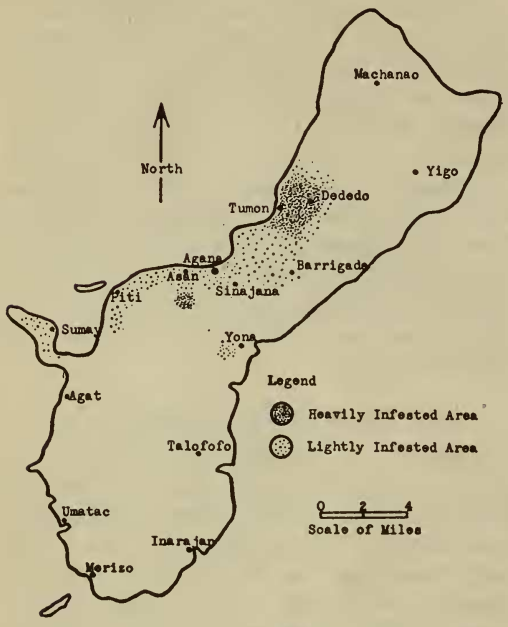

FIG. 1—Map of Guam showing relative infestations of *Ancylonycha mindanaona* and infested localities.

ranging from 35 to 95 percent on sites where infestations ranged from 0.4 to 1.2 larvae per square foot of surface-soil area. A larval infestation slightly exceeding an average of 1 specimen per square foot was sufficient to destroy most of the young corn plants. In June, 1938, adults demonstrated their destructiveness to tasseling corn by causing an estimated defoliation of 50 percent in several fields observed. From March to May of the same year many banana leaves in the Dededo district were denuded and large portions of the leafy area on coconut palms were stripped by the beetles.

FOOD PLANTS

Surveys of adult and larval infestations from 1937 to 1939 revealed hosts to be attacked as indicated below.

Cultivated Hosts	*Stage of Pest*
Avocados (*Persea* spp.)	Adults
Bananas (*Musa* spp.)	Adults
Beans (*Phaseolus* spp.)	Larvae
Breadfruit (*Artocarpus* spp.)	Adults
Cassava (*Manihot utilissima*)	Adults
Citrus (*Citrus* spp.)	Larvae
Coconut palm (*Cocos nucifera*)	Adults and larvae
Coffee (*Coffea* spp.)	Larvae
Corn (*Zea mays*)	Adults and larvae
Kapok (*Ceiba pentandra*)	Adults
Wild Hosts	
(Baryxylum) *Peltophorum inerme*	Adults
Bauhinia malabarica	Adults
Carissa arduina	Adults
Cestrum pallidum	Adults
Euphorbia didyma	Adults
Grasses (several varieties)	Larvae
Guamia marannae	Larvae
Hibiscus tiliaceus	Adults
Leucaena glauca	Adults
Malpighia glabra	Adults
Phyllanthus sp.	Larvae
Pithecellobium dulce	Adults
Sida rhombifolia	Larvae
Urena lobata	Larvae

There are probably other hosts in addition to those in the foregoing list. Roots of grasses, weeds, corn, and coconut palms are preferred hosts of the larvae, while leaves of bananas, coconut palms, tasseling corn, and Manila tamarind (*Pithecellobium dulce*) are preferred by adults.

DESCRIPTION

EGG

The freshly deposited egg is pearly white, elliptical, approximately 2 mm in length, and slightly more than 1 mm in diameter. It begins enlarging on the second day of incubation, becomes oval by the fifth day, and attains a size from 2 to 3 times the original before it hatches.

LARVA AND PUPA

Descriptions by Dr. Adam G. Böving may be found in the following paper herein.

ADULT

The original description of *Ancylonycha mindanaona* by Brenske was somewhat brief. The ensuing description was therefore prepared by Dr. E. A. Chapin:

Color above medium to pale castaneous, head and pronotum slightly darker than elytra,

underparts paler, yellowish brown, legs castaneous with extreme apices of tibiae (entire outer margin of anterior tibia) darker, apices of mandibles and maxillae nearly black.

Head coarsely and closely punctured, the punctures tending to form longitudinal groups of two or three. Clypeal suture slightly sinuate, clypeus with strongly reflexed anterior margin which is very broadly and very feebly notched at middle. Antenna 10-segmented, club in male about as long as first segment, in female about three-fourths as long as first.

Pronotum more than twice as broad as its length along median line, all margins finely beaded, apical angles subacute, basal angles obtuse, lateral margins nearly parallel in apical fourth, thence strongly diverging to basal third, the point of greatest breadth of pronotum. Surface moderately coarsely and sparsely punctured on disc, more finely and densely punctured in lateral thirds.

Scutellum broadly triangular, with a few coarse punctures.

Elytron with prominent humeral callus and moderately convex sutural bead, apical sutural angles in male minutely mucronate, in female simple. Surface as coarsely and slightly more densely punctured than disc of pronotum, with very feeble traces of three discal costae. Pygidium sparsely and coarsely punctured.

Underparts of metathorax rather finely and densely punctured, rather densely clothed with pale hair. Abdominal sternites, except terminal, completely anchylosed with sutures obliterated across middle, very sparsely punctured at middle, more dense laterally. Terminal sternites not notably different in the sexes. Tarsal claw strong, moderately curved, accessory tooth acute and subbasal.

Aedeagus, Figs. 1–3; female genital plates, Fig. 4.

Length: 17–19 mm.

Known distribution: Philippine Islands (Mindanao and Luzon); Guam.

The identification of the Guam specimens was based on comparison with material from Mindanao in the C. F. Baker Collection identified by the late J. Moser.

LIFE HISTORY AND HABITS

Studies of the life history of *Ancylonycha mindanaona* were conducted under field conditions from July, 1937, to May, 1939, and in an open-air insectary from March through May in 1938–39, when pupae, adults, and eggs were abundant. Adults collected in the field in April, 1938, were confined to cages kept in an undisturbed shed, because females would not oviposit under insectary conditions.

DEVELOPMENTAL PERIODS

The records shown in Table 1 were obtained for eggs in April, 1938, for larvae from April, 1938, to March, 1939, and for pupae, including some specimens developing from mature larvae collected in the field, from March to May, 1938–39. It may be seen from these that the insect has an annual life history.

TABLE 1.—LENGTH OF IMMATURE STAGES OF ANCYLONYCHA MINDANAONA UNDER CAGE CONDITIONS

Stage	Specimens	Length of Stage		
		Minimum	Maximum	Average
	Number	*Days*	*Days*	*Days*
Egg	205	11	15	12.1
Larva	19	290	309	301
Prepupa	45	5	20	[1]
Pupa	30	16	20	17.4
Egg to adult	19	323	346	335

[1] No complete data.

The eggs studied were deposited by the beetles in boxes of sifted moist soil placed in cages with adults early in the morning and removed at dusk when beetles emerged to feed. Eggs were incubated in small tins and in partially open petri dishes containing moist soil.

Newly hatched larvae were placed in drums containing a mixture of leafmold and soil previously planted to centipedegrass, *Eremochloa ophiuroides*. Periodical observations of the grass roots established approximate periods when larvae changed from feeding on soil organic matter to living plant material. On January 31, 1939, the larvae, having discontinued their feeding, were transferred singly into vials containing sufficient soil for the formation of pupal cells. After entering the prepupal stage each specimen was placed on a layer of cellu-

cotton covering a layer of soil, needed to supply moisture, in a vial where dates of pupation and final transformation to adult could be established. The open end of every vial was loosely plugged with cotton to retard the escape of moisture. Subsequent attempts to ascertain pre-emergence periods of adults newly transformed from pupae, by holding them separately in caged tin cans of soil under insectary conditions, resulted in failures, as no specimens emerged and all died within a few weeks.

LARVA

The length of the larval stage, ranging from 290 to 309 days (Table 1), was possibly shortened under cage conditions. The young larva, hatching in March or April, remains at a depth of 5 or 6 inches in the soil, where it feeds on decaying organic matter until it is almost full-grown in July, when the summer rainy season begins. Moisture conditions then being favorable, it rises closer to the soil surface to attack living roots of an abundant weedy and grass growth, or other hosts. If the host is cleared away before November and is replaced by a cultivated crop, the latter—corn for example—is attacked as soon as roots develop. The larva burrows more deeply into the soil from late November to January, probably to escape dry surface-soil conditions following reduction in rainfall, and forms an earthen pupal cell by January if a food supply is absent. Some larvae may continue feeding until March or later if a host is available. The cell is usually to be found near a limestone rock formation ranging in depth, at Dededo, from 5 to 13 inches. The latter depth is generally sought, judged from groups of mature larvae and pupae often found in small areas where the soil was slightly deeper than the average surrounding soil depth. The larva remains in the cell for days, or even weeks, turns slightly brown, becomes limp, shrinks to almost half its former size, and finally casts its skin to become a pupa.

PUPA

The first noticeable change in a pupa in transforming to an adult is the early replacement of the pearly-white color by a creamy color. The eyes and tibia become slightly brown on the fifth day, as do the head and thorax on the seventh day. The entire specimen is brown by the eleventh or twelfth day. The pupal skin is then cast several days later to complete the transformation.

ADULT

Feeding habits.—The adult remains in its pupal cell for several days after transformation, before emerging to feed. After maturity, it emerges from the soil at dusk, flies

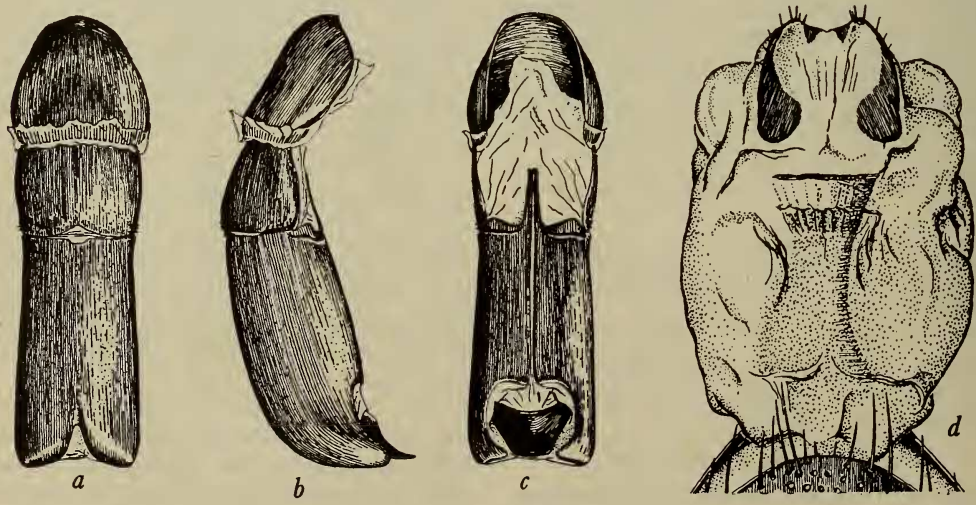

FIG. 2.—*Ancylonycha mindanaona: a–c,* male genitalia; *d,* female genitalia. Drawings by A. D. Cushman.

briefly or until a desirable host is reached, then feeds voraciously for an hour or two on the outer edge of a leaf. It mates later during the night and continues to feed until just before daybreak, when it flies to soil nearby, hiding during the day at depths of 2 to 6 inches.

The adult probably continues to feed nightly throughout its life after its emergence from the pupal cell. Although average adult longevity appears to be of only a few weeks' duration, the individual beetle consumes a large amount of leafy material.

Oviposition habits.—When a female discontinues feeding at daybreak, it flies to the ground, burrows to a depth of from 4 to 6 inches, and spends the day either resting or ovipositing. Eggs are laid singly, or in groups of 2 to 5. A glutinous substance secreted on each egg causes soil to adhere to it as a protective covering. The total number of eggs an adult may deposit was not established, although dissections of numerous females indicated an average of about 30.

Small valleys or depressions where moisture prevailed during the dry season appeared to be more favorable to larval survival but were apparently given little preference by females for oviposition sites. It even seemed doubtful that the type of plant cover had much influence on the selection of places for oviposition. That there was some selection of loose soils is supported by the fact that larvae were found mostly in sandy portions of lowland soils at Piti in 1938–39. Adults probably had difficulty in penetrating the clay loam soils, particularly in uncultivated areas, which were dry and well baked during the season of oviposition. Concentrations of larvae in Dededo fields during the fall of 1937–38 were invariably found near host plants of the adults. In one cornfield, for example, 100 percent of the plants were destroyed by larvae in an area located within 75 feet from the forest edge, but at a greater distance only an occasional plant was molested.

SEASONAL OCCURRENCE

There is a slight overlapping of the one generation per year of *Ancylonycha mindanaona* in Guam (Table 2).

TABLE 2.—SEASONAL OCCURRENCE OF THE VARIOUS STAGES OF ANCYCLONYCHA MINDANAONA AT DEDEDO, GUAM, IN 1938–39

Stage	Period of occurrence[1]	Period of greatest prevalence
Adults....	Feb. 20 to Aug. 15	March 15 to April 30
Eggs.....	Feb. 25 to June 1	March and April
Larvae....	March 10 to May 25 of succeeding year	June and July
Pupae.....	Feb. 1 to May 30	March

[1] Exact dates given represent the earliest and latest dates on which individuals were actually observed in the field.

At Dededo in 1938 the beetle flight began late in February and at Piti early in March. During the same year the maximum flight occurred about April 20 at the latter place, according to data obtained from small catches of beetles in light traps. The data also showed a rapid decline in the population later and a complete disappearance of beetles by August 6. Oviposition begins almost immediately after the first beetle emergence, but apparently ceases long before the last beetles of a season disappear.

Larvae of a single generation occur over a period covering almost 15 months (Table 2). The peak population is reached in June or July, or within 3 to 4 months after the first appearance of larvae in March, then starts to decline. It develops during a period of dry weather, which may cause considerable mortality of both eggs and young larvae. The 1938 generation appeared small in size in July, by comparison with the number of beetles present to oviposit in the previous March and April, and was less than one-fifth of its maximum level by January, 1939, according to results of surveys conducted in 10 fields. Maximum concentrations of approximately 8 larvae per square foot of surface soil existed in July at one site, as compared with 1 larva per 10 square feet in November.

CLIMATIC AND SOIL CONDITIONS IN GUAM POSSIBLY AFFECTING LIFE HISTORY

Soils on the Island of Guam are largely of three general types—the shallow upland limestone type, lowland clay loams, and savannah lands. The upland soils are porous and shallow with an underlying limestone-rock formation, of which outcroppings are frequently to be seen; are usually from 6 to

8 inches in depth but may be a few inches deeper at some sites; and have little water-holding capacity. The lowland and savannah-land soils are several feet in depth; the former having small sandy areas in spots. The savannah soils cover the greater portion of the southern half of the Island and produce a thick growth of swordgrass. Infestations of *Ancylonycha mindanaona* were most severe in the loose upland soils prevalent at Dededo and near Asan, and in the limited sandy areas in the lowland at Piti. No infestations were observed in the savannah lands.

The average total annual rainfall in Guam for the period July 1, 1937, to June 30, 1939, was 79.77 inches, a reduction from a normal average of approximately 95 inches. Most of it occurred during a distinct rainy season extending from June to November and was followed by a dry season from January to May during which time the average monthly rainfall amounted to less than 5 inches. The temperature and relative humidity were less variable, the former ranging from 71° to 92°F. and the latter averaging 80.8 percent. Daily mean minimum and mean maximum temperatures approximated 74° and 87°, respectively.

Crops growing in lowland areas during the period from December to June suffer from lack of rainfall; nevertheless they often yield fair-sized harvests. Those in upland areas, however, must as a general rule reach maturity by December, in order to escape drastic effects of too little rainfall from that month to the following May. Young crops are likely to be drowned out in either area by excessive rainfall, sometimes exceeding 25 inches, in August. Favorable months for planting corn in the upland areas are therefore limited to May, June, September, and October. The problems of successful grain storage, inadequate land acreage for cultivation, and an even distribution of labor make plantings in the two last-named months very desirable, yet they fit favorably into the habits of the larvae of *Ancylonycha mindanaona*.

SUMMARY

The scarabaeid beetle *Ancylonycha mindanaona* (Brenske) was a destructive pest in both the larval and adult stages in Guam in 1937–38. The 1939 generation was smaller than the previous ones. The larvae feed on roots of plants and the adults attack foliage at night.

Life-history studies proved that the pest completed its cycle in one year, with an egg stage of from 11 to 15 days, an approximate 10-month larval stage, and a pupal stage of 16 to 18 days. Eggs occur largely from March to May, larvae from March of one year to March of the following year, pupae from February to May, and adults from February to August with the peak in April.

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